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Wisconsin Department of Commerce

Evaluation # 200814-I

Safety & Buildings Division
201 West Washington Avenue
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Wisconsin Building Products Evaluation

Material	Insulated Concrete Forms
Manufacturer	Amvic Inc. 501 McNicoll Avenue Toronto Ontario, Canada M2H 2E2

SCOPE OF EVALUATION

GENERAL: This report evaluates the use of the Amvic Insulated Concrete Form Wall System, manufactured by Amvic Inc., evaluated as permanent structural form work and insulation system for load-bearing and non-load-bearing, below-grade and above-grade walls. The forms are used in construction of plain and reinforced concrete beams, lintels, exterior and interior walls, and foundation and retaining walls. The forms are allowed for use in buildings of noncombustible construction when installed in accordance with this evaluation. The Amvic Insulated Concrete Form Wall System was evaluated for safety requirements of the foam plastic and structural requirements for the codes listed below.

This review includes the cited **Comm** code requirements below in accordance with the current **Wisconsin Uniform Dwelling Code for 1 & 2 family dwellings (UDC):**

- **Foam Plastic:** The Amvic Insulated Concrete Form Wall System was evaluated in accordance with the fire safety requirements of **s. Comm 21.11**.
- **Structural:** The Amvic Insulated Concrete Form Wall System was evaluated in accordance with the structural requirements of **ss. Comm 21.02,** and **21.02(3)(c)**.

The **IBC** requirements below in accordance with the current **Wisconsin Amended 2006 ICC Code:**

- **Foam Plastic:** The Amvic Insulated Concrete Form Wall System was evaluated in accordance with the fire safety requirements **ss. IBC 2603.1**, **2603.2**, and **2603.3**.
- **Structural:** The Amvic Insulated Concrete Form Wall System was evaluated in accordance with the requirements of **IBC Chapter 16**.
- **Fire Endurance:** The Amvic Insulated Concrete Form Wall System was evaluated in accordance with the requirements of **ss. IBC 2603.4**, **2603.5.1**, and **2603.5.2**.

Note: Structural calculations shall be submitted (job-to-job basis) in accordance with IBC Chapter 16 for Live, Ground Snow, Roof, Wind, and Seismic Loads.

DESCRIPTION AND USE

General: The Amvic Insulated Concrete Form Wall System consists of expanded polystyrene (EPS) forms which are stacked in running bond and serve as forms for either 4-, 6-, 8-, 10- and,12-inch-thick reinforced concrete wall. The EPS forms remain in place to provide insulation for the wall. The reinforced concrete wall system may be used as a foundation wall, basement wall, shear wall, exterior load-bearing wall and lintel section.

The Amvic expanded polystyrene EPS forms are 48 inches long (measured at the center of the board), 16 inches high and each opposing form panel is 2.5-inches thick. The 4-inch Amvic form for 4-inch-thick reinforced concrete walls is 9 inches wide. The 6-inch Amvic form for 6-inch-thick reinforced concrete walls is 11 inches wide. The 8-inch Amvic form for 8-inch-thick reinforced concrete walls is 13 inches wide. The 10-inch Amvic form for 10-inch-thick reinforced concrete walls is 15 inches wide. The 12-inch Amvic form for 12-inch-thick reinforced concrete walls is 17 inches wide. The solid-form blocks consist of opposing form panels connected by 8 polypropylene web ties embedded into the panels forming a solid form block. The polypropylene plastic web ties are spaced 6 inches on center. Corner rods are field installed to provide a means to attach interior and exterior wall coverings.

Material: Amvic Form Blocks are molded from modified expandable polystyrene (EPS) beads.

Product	**Manufacturer**
Expanded Polystyrene (EPS)	Amvic

The blocks are manufactured to a nominal density of 1.50 pounds per cubic foot, Type II

Concrete: Normal-weight concrete complying with **s. Comm 21.02(3)(b)**, and **s. IBC 1903.1** with maximum aggregate size of ¾-inch and a minimum compressive strength of 2,500 psi at 28 days.

Reinforcement: The concrete is reinforced with Nos. 3, 4, 5 and 6 deformed steel reinforcing bars, Type A615, Grade No. 40, with minimum yield strength of 40,000 psi and Grade No. 60, with minimum yield strength of 60,000 psi. All steel reinforcement shall be in accordance with **s. IBC 1907**.

Polypropylene Webs and Corner Rods: The polypropylene webs are used to connect the EPS boards and for attaching interior and exterior finishes. The webs have openings to allow concrete to pass through. The webs vary in length and have 1-1/2-inch-wide-by-15-1/2-inch-high-by-0.118-inch-thick flanges. The plastic flange is embedded ½-inch below the outside surface of the EPS form.

The corner rods are 1-inch-by-1-inch extruded polypropylene hollow square tubes with a wall thickness of 0.125-inch. The rods shall be field installed in vertical openings at all corners of the Amvic units to provide a means for attaching interior and exterior wall coverings.

Other Components: Where required, wood members in contact with concrete for plates or window and door framing shall be preservative-treated in accordance with **s. Comm 21.10** of the **Wisconsin Uniform Dwelling Code for 1 & 2 family dwellings (UDC)**, and **s. IBC 2303.1.8** of the **Wisconsin Amended 2006 ICC Code**, and shall be attached with hot-dipped galvanized steel fasteners in accordance with **s. IBC 2304.9.5.**

Each pallet of Amvic Inc. forms shall bear a label with the manufacturer's name, and the quality control inspection agency (Intertek Testing Services NA, Ltd.—Warnock Hersey (AA-688).

TESTS AND RESULTS

The tests and results listed below cover the **Wisconsin Uniform Dwelling Code (UDC), (for 1- and 2-family dwellings)** and the current **Wisconsin Amended 2006 ICC Code** requirements:

Intertek Testing Services, ETL SEMKO, conducted testing on the Amvic EPS boards. The Amvic insulated concrete forms produced by Amvic Inc., have been subject to and complied with the following testing:

- The Amvic EPS boards have a maximum flame-spread rating of 25 or less and a maximum smoke-developed rating of 450 or less. Testing was done in accordance with ASTM E 84.
- Room fire Test Standard for Interior of Foam Plastics Systems in accordance with ASTM D1929, and D2843.
- Crawl Space evaluation conducted in accordance with ICBOES requirements.
- Conforms to ASTM C578, with equivalency CAN/ULC S701 (standard Specification for Rigid, Cellular Polystyrene Thermal Insulation).
- Fastener Withdrawal Evaluation in accordance with ASTM D1761.
- Fastener Lateral Resistance tested in accordance with ASTM D1761.
- Polypropylene web material conforms to CC1 Plastic material when tested in accordance with ASTM D1929, D635, and D2843.

The Rigid Cellular (RCPS) Polystyrene Thermal Insulation was tested for apparent density, compressive properties, and flexural properties in accordance with ASTM C578-95 "Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation," using the following test methods:

- **Apparent Density:** ASTM D1622-98 "Standard Test Method for Apparent Density of Rigid Cellular Plastics".

Type	Test Result	Minimum Requirement	Status
Type II	1.40 lbs/ft^3	1.35 lbs/ft^3	Complied

- **Compressive Properties:** ASTM C1621-94 "Standard Test Method for Compressive Properties of Rigid Cellular Plastics".

Type	Test Result	Minimum Requirement	Status
Type II	19.8 psi	15.0 psi min.	Complied

- **Flexural Properties:** ASTM C203-99 "Standard Test Method for Breaking Load and Flexural Properties of Block-Type Thermal Insulation"

Type	Test Result	Minimum Requirement	Status
SC Type II	42.57 psi	40.0 psi min.	Complied

- **Water Vapor Permeance:** ASTM E96-94 "Standard Test Method for Water Vapor Transmission of Materials"

Type	Test Result	Minimum Requirement	Status
SC Type II	130.1 ng/Pa ● s ● m^2	200 ng/Pa ● s ● m^2	Complied

Physical properties testing of polypropylene reinforcing web material was performed in general accordance with the following test methods:

- **Screw Withdrawal:** ICBO ES AC 116 "Acceptance Criteria for Nails and Spikes," in conjunction with ASTM D1761"Standard Test Methods for Mechanical Fasteners in Wood, (two types of fasteners were tested: a type 'W' coarse thread drywall screw, and a type 'S' fine thread drywall screw)

	Fastener Type	Withdrawal	Shear
		Max Load (lbs)	Max Load (lbs)
Average	Type 'W' Coarse Thread Drywall Screw	144.0	207.0
COV	Type 'W' Coarse Thread Drywall Screw	24.3 %	10.6 %
Average	Type 'S' Fine Thread Drywall Screw	135.0	190.0
COV	Type 'S' Fine Thread Drywall Screw	16.07 %	17.6 %

- **Lateral Screw Resistance:** ICBO ES AC 116 "Acceptance Criteria for Nails and Spikes," in conjunction with ASTM D1761"Standard Test Methods for Mechanical Fasteners in Wood.

- **Tensile Strength:** ASTM D638-99 "Standard Test Method for Tensile Properties of Plastics"

	Ultimate Tensile Strength (lbs)
Average	810
COV	4.98 %

DISCUSSION: ICBO ES AC 116 references ASTM D1761 for lateral and withdrawal testing. The ASTM D6117 and ASTM D1761 are very similar in methodology, however ASTM D6117 is used for solid sections of plastic members and not for sheets of plastic material. In addition to this, the ICBO ES AC 116 document gives guidance on establishing allowable loads, which ASTM D6117 does not provide. In the absence of a standard that more specifically addresses this issue, ITS recommends that AC 116 is more appropriate.

It is ITS's opinion that it is appropriate to state specific loads for this material. ASTM D5456-99 clause A2.6.1 states, "The equivalent specific gravity is determined from Table 12.21 or Ref. (3) such that the table value for the tested nail does not exceed the average ultimate withdrawal resistance in pounds per inch (N/mm) from A2.4 divided by 5.0…" The safety factor for withdrawal in ASTM D5456 matches that of AC 116, again justifying its applicability to this issue. ASTM D5456 does not have a comparable safety factor for lateral load resistance. In the absence of a standard that more specifically addresses this issue, we suggest that AC 116 is more appropriate.

Given the low C.O.V. of the web tensile test results, it is the opinion of ITS that a safety factor of approximately three is appropriate. We chose to use the lateral resistance factors of AC 116 for consistency.

CALCULATIONS:

Web Tensile:

810 lbs. x 0.75 = 607.8 lbs.
(Proportional limit assumed to be the same as ultimate load – brittle failure)
810 lbs. ÷ 3.2 = 253.25 lbs.
(Based on average ultimate load)

Fastener Testing:

(A) Withdrawal Resistance:

Type "S" Screw F_{allow} = 135.0 lbs. ÷ 5 = 27.0 lbs.
Type "W" Screw F_{allow} = 144.0 lbs. ÷ 5 = 28.8 lbs.

(B) Lateral Resistance:

Type "S" Screw F_{allow} = 190.0 lbs.(1-2 x 17.6%)/2.24 = 54.9 lbs.
Type "W" Screw F_{allow} = 207.0 lbs. (1-2 x 10.6%)/2.24 = 72.8 lbs.

CONCLUSIONS:

1. Physical Properties of Polypropylene Reinforcing Webs

The polypropylene reinforcing webs were found to have the following allowable loads, as recommended by ITS when analyzed in accordance with ICBO ES AC 116 "Acceptance Criteria for Nails and Spikes." The withdrawal resistance utilized a safety factor of five as per ICBO ES AC 116, Section 4.2. The lateral resistance utilizes a Safety Factor of 4.47 when analyzed in accordance with ICBO ES AC 116, Section 4.1 using the maximum C. O. V. 24%.

- Withdrawal resistance of a Type "S" fine thread drywall screw is 27.0 lbs.
- Withdrawal resistance of a Type "W" coarse thread drywall screw is 28.8 lbs.
- Lateral resistance of a Type "S" fine thread drywall screw is 54.9 lbs.
- Lateral resistance of a Type "W" coarse thread drywall screw is 72.8 lbs.

The polypropylene reinforcing web tensile strength is recommended by ITS to be 253.3 lbs., based on a safety factor of 3.2 analyzed in accordance with ICBO ES AC 116, Section 4.1. The maximum negative wind pressure for a cladding system attached to the EPS foam plastic panels is based on the maximum fastener values connected into the polypropylene reinforcing webs. For a screwed system into the webs @ 8 inches on center vertically, and 6 inches on center horizontally, the allowable negative withdrawal is 81.0 lbs./ft^2. This value converted to a wind speed is equal to the square root of the allowable withdrawal in lbs./ft^2 divided by 0.00249. For an allowable negative withdrawal of 81.0 lbs/ft^2 the negative wind pressure is equal to 180 mph.

- **ASTM E119** Fire Test of Building Construction and Materials, a 3-hour full-scale vertical fire test conducted on a load-bearing 4-inch concrete core, 3-hour full scale vertical fire test conducted on a load-bearing 6-1/4 inch concrete core. Amvic insulated concrete form wall assembly with a load of 10,000 lbs per linear foot. See test construction below.

  Fire-Resistance-Rated Wall Assembly: The 6-inch-thick concrete core walls constructed with Amvic ICF's has a three hour fire-resistance rating, and is rated for exposure to fire from both sides. The normal-weight concrete must have a minimum 28-day compressive strength of 4,000 psi. The minimum size reinforcement shall be No. 5 steel reinforcements spaced as required by ACI 318, at a minimum; 16 inches on center vertically and horizontally, and shall be staggered on either side of the vertical bars, from row to row. The maximum axial compressive load shall be 7 % of the load determined in accordance with **Chapter 19** of the IBC.

  The interior finish wall finish is 1/2-inch-thick Type X gypsum wall board installed either vertically or horizontally, and shall be attached to the flanges with minimum 0.136-inch-diameter-by-1 1/2-inch-long, Type W Bugle Head Screws, coarse-threaded gypsum wallboard screws spaced 16 inches on center vertically and a maximum of 12 inches on center horizontally, anchored into the high density polypropylene web tie material. Gypsum wallboard joints and screws heads shall be taped and filled with joint compound.

  The exterior wall covering is ¼-inch-thick Hardi Backerboard attached with 1 ¼-inch-long, corrosion resistant (galvanized or stainless steel) roofing nails or minimum 1-inch-long, No. 8 by 0.323-inch HD self-drilling, corrosion-resistant, ribbed bugle head screws. Fasteners must be a maximum of 8 inches on center around the perimeter and in the field. Fasteners must be located a minimum of 3/8-inch and a maximum of ¾-inch from the backer board edges. The allowable design axial load capacity of the bearing wall is 10,000 lbf/ft per 10-foot wall height.

  In lieu of ¼-inch-thick Hardi Backerboard, the Amvic ICF's may be covered with any exterior cladding material having a minimum ¼-inch-thickness. Vinyl siding must be applied over minimum ¼-inch-thick plywood or OSB.

LIMITATIONS OF APPROVAL

The limitations below are in accordance with the current **Wisconsin Uniform Dwelling Code (UDC), (for 1 & 2 family dwellings)** and the current **Wisconsin Amended ICC Code:**

- **Foam Plastic:** The Amvic Inc. is approved for use with a thermal barrier to separate the blocks from interior spaces in accordance with **s. Comm 21.11(1)**. Where a 1-inch thickness of masonry does not separate the polystyrene blocks from the building interior, including at the top of the wall, a thermal barrier, which has a finish rating of at least 15 minutes, shall be provided.

1. Amvic Form Blocks are approved for use in combustible non-rated construction in accordance with **s. Comm 21.11**. In one- or two-family dwellings, thermal barriers shall be provided to separate the forms from the occupied space of the dwellings per **s. Comm 21.11**.
2. The exterior face of the blocks shall be finished with an approved weather covering and must be protected from ultraviolet light.

- **Structural:** The Amvic Form Blocks are approved as structural building elements.

1. The units are approved for use as concrete forms for basement walls and exterior walls when the resulting concrete core thickness satisfies **Table 21.18-A** for one- or two-family dwellings, or when structural calculations for the product are submitted for review.
2. Walls shall be anchored to all floors and roofs. Walls shall be interconnected at corners by embedding and lapping the reinforcement.
3. Structures are **limited** to two stories in height.
4. The forms are approved for use as concrete forms for basement walls, exterior walls and retaining walls when structural calculations are submitted to the department by a Wisconsin registered professional engineer or architect.
5. Below grade walls shall be damp-proofed when required by the local building department.

6. Damp-proofing and water-proofing materials shall be approved by Amvic Inc and the local building official, and shall be free of solvents that will adversely affect the EPS foam.

NOTE: The Amvic Form Blocks were **not** evaluated for compliance with the thermal requirements of **Subchapter VI, ss. Comm 22.20**, **22.21**, **22.23**, **22.25**, **22.27**, **22.28**, and **22.31**. of the current UDC.

The **IBC** limitations below are in accordance with the current **Wisconsin Amended IBC 2006 Code:**

- **Foam Plastic:** The Amvic Inc. is approved for use with a thermal barrier to separate the blocks from interior spaces in accordance with **s. IBC 2603.4.**

1. In accordance with **s. IBC 2603.4.1.6**, when the Amvic ICF is used within the attic or crawl space where entry is made only for service utilities, the foam plastic insulation shall be protected against ignition by 1-1/2" thick mineral fiber insulation, a ¼" thick wood structural panel, particleboard or hardboard, gypsum wallboard, corrosion-resistant steel or other approved material installed so that the foam plastic is not exposed.
2. The protective covering shall be consistent with the requirements for the type of construction.
3. The exterior face of the blocks shall be finished with an approved weather covering and must be protected from ultraviolet light.
4. The crawl space shall not be used for storage or air handling purposes, there are no interconnected basement areas and entry to the crawl space is only for service of utilities.

- **Structural:** Design of concrete formed by Amvic Forms must comply with **IBC Chapter 16** and **IBC Chapter 19** with the following requirements:

1. *The forms are approved for use as concrete forms for basement walls, exterior walls and retaining walls when structural calculations are submitted to the department by a Wisconsin registered professional engineer or architect.
2. *Design calculations of walls must comply with **s. IBC 1901.2.** Use of the empirical design approach specified in **s. 2109.1** is prohibited.
3. Design of lintels shall comply with the applicable provisions of **IBC Chapter 16.**
4. Wall loading shall be in accordance with **IBC Chapter 16**.
5. Minimum wall reinforcement shall conform to **s. IBC 1901.2**. When the code requires that vertical and horizontal reinforcement be spaced no further apart than 18 inches or three times the wall thickness, whichever is less, the maximum concrete wall thickness along the length of the wall is permitted to be used to determine rebar spacing.
6. Walls shall be anchored to floors and roofs in accordance with **s. IBC 1604.8.2**. Walls shall be interconnected at corners by embedding and lapping reinforcement in accordance with the code.
7. Design of shear walls shall be in accordance with **ss. IBC 1901.2**.
8. Structures are **limited** to two stories in height plus a basement.
9. Below grade walls shall be damp-proofed when required by the local building department, water-proofed in accordance with **s. IBC 1807**.
10. Damp-proofing and water-proofing materials shall be approved by Amvic Inc., and the local building official, and shall be free of solvents that will adversely affect the EPS foam.
11. Special inspection is required as noted in **s. IBC 1704**, for placement of reinforcing steel and concrete, and for concrete cylinder testing, except that special inspection is not required for foundation stem walls conforming to **Table 1805.4.2** of the **IBC**.

    a) Wall systems are a maximum of 8 feet high and are limited to use in single-story construction of Group R-3, or Group U Occupancies.
    b) Maximum height of a concrete pour is 48 inches. Succeeding lifts must be placed in accordance with **s. IBC 1905.10.**
    c) Installation is by properly trained installers approved by Amvic Inc.
    d) The installation instructions indicate methods used to verify proper placement of concrete.

12. Walls constructed with Amvic ICF are considered Type V Construction.
13. Walls constructed with Amvic insulated concrete form blocks are considered **Type VB Construction**. When constructed in accordance with the fire-resistance-rated wall assembly detailed in the **TEST AND RESULTS** section of this approval the Amvic ICF forms are recognized for use in buildings of **Type VA Construction**.

***Alternate Design:** In lieu of calculations, the structural design of reinforced concrete formed by Amvic Insulated Concrete Form Wall System insulated concrete form blocks for residential construction is permitted to comply with the *Prescriptive Method for Insulating Concrete Forms in Residential Construction* (publication No. EB118), dated May 1998, published by the Portland Cement Association (PCA). Buildings constructed with the Amvic Insulated Concrete Form Wall System insulated concrete form system and designed in accordance with the alternate design, will not exceed a height of two stories plus a basement, where the maximum unsupported wall height is 10 feet.

NOTE: The Amvic Inc. was **not** evaluated for compliance with the thermal requirements of **s. Comm 63.1018**.

Identification: Each package bears a label specifying the name and address of the manufacturer (Amvic Inc., Toronto Ontario, Canada). Additionally, product labels indicate the Wisconsin Building Product Evaluation Number (**200814-I**), and the name and logo of the quality control agency.

This approval will be valid through December 31, 2013, unless manufacturing modifications are made to the product or a re-examination is deemed necessary by the department. The product approval is applicable to projects approved under the current edition of the applicable codes. This approval may be void for project approvals made under future applicable editions. The Wisconsin Building Product Evaluation number must be provided when plans that include this product are submitted for review.

DISCLAIMER

The department is in no way endorsing or advertising this product. This approval addresses only the specified applications for the product and does not waive any code requirement not specified in this document.

Revision Date:
Approval Date: November 3, 2008 By: _____

Lee E. Finley, Jr.
Product & Material Review
Integrated Services Bureau

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